AGENDA

WDSA Task Committee on Premise Plumbing Modeling
Thursday, December 19, 2019
1:30 PM – 3 PM (EST)
Call In: Ex. 6 Personal Privacy (PP)

Meeting Objective:
To further discuss PPM Workshop planning.

1:30 PM - Workshop Planning discussion

1. Status of the second wave participants (attachment 1).
    a. Additional recommendation from second wave participants (attachment 2).
2. Status of EWRI Sponsorship.
3. PPM Example paper (attachment 3).
    a. When do we send out?
    b. One or more papers from other organizers?
    c. Encourage those who cannot attend the workshop to submit their paper(s) for inclusion in the proceedings?
4. Research Gap document (attachment 4)
5. Review of preliminary schedule leading to workshop (attachment 5).
6. Centralized web/cloud storages → ASCE Collaborate, Google Storages, Dropbox, etc.?
7. Any possibility of having a live video feed for the workshop? E.g. the last hour on the second day where we summarize the results of the workshop.
8. EWRI Currents newsletter
9. Others.

3 PM – End of meeting

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Attachments:

1. Workshop participant List Version 7. (including participation status from the second wave invitees);
2. Recommended participant list from the second wave;
3. Example papers;
4. Draft research gap document template;
5. Grayman's 2-page memo (preliminary schedule leading to workshop);

ATTACHMENT I

PPM Workshop Participant List Version 7

Prioirty Participants for Workshop on Premise Plumbing Modeling (USEPA Breidenbach Research Lab, April 22-23, 2020)

No	Name	Title	Affiliation	email
1	Ahmed Abokifa	Assistant Professor	Univ of Illinois, Chicago	abokifa@uic.edu
2	Andrew Whelton	Associate Professor	Purdue University	awhelton@purdue.edu
3	Bill Platten		USEPA	platten.william@epa.gov
4	Feng Shang		USEPA	Shang.feng@epa.gov
5	Jonathan Burkhardt		USEPA	Burkhardt.Jonathan@epa.gov
6	Juneseok Lee	Associate Professor	Manhattan College	juneseok.lee@manhattan.edu
7	Lew Rossman		Retired (USEPA)	Ex. 6 Personal Privacy (PP)
8	Mark LeChevalier		Dr. Water	Ex. 6 Personal Privacy (PP)
9	Martin Lambert	Professor	University of Adelaide	martin.lambert@adelaide.edu.au
10	Michele Prevost	Professor	Polytechnique Montréal	michele.prevost@polymtl.ca
11	Mirjam Blokker	Principal scientist	KWR	Mirjam.Blokker@kwrwater.nl
12	Olivier Piller	Senior Research Scientist	IRSTEA	olivier.piller@irstea.fr
13	Regan Murray		USEPA	Murray.Regan@epa.gov
14	Rob Janke		USEPA	Janke.Robert@epa.gov
15	Simoni Triantafyllidou		USEPA	Triantafyllidou.Simoni@epa.gov
16	Steven Buchberger	Professor	University of Cincinnati	buchbesg@ucmail.uc.edu
17	Tania Ullah		NIST	tania.ullah@nist.gov
18	Terra Haxton		USEPA	haxton.terra@epa.gov
19	Tom Walski	Vice President	Bentley	tom.walski@bentley.com
20	Vanessa Speight	Research Fellow	University of Sheffield	v.speight@sheffield.ac.uk
21	Walter Grayman	Owner	W.M. Grayman Consulting Engineer	Ex. 6 Personal Privacy (PP)
22	William Samuels	Director	Leidos	william.b.samuels@leidos.com
23	Yeongho Lee		GCWW	Yeongho.Lee@gcww.cincinnati-oh.gov
24	Kevin Lansey	Professor	University of Arizona	lansey@email.arizona.edu

Last Update: 12/18/19

Potential Participants for Workshop on Premise Plumbing Modeling (USEPA Breidenbach Research Lab, April 22-23, 2020)

No	Response	Name	Title	Affiliation	email	Status	Comment (optional)	Your Initials
	YES (check with management)							
1		Rakesh Bahadur		Leidos	RAKESH.BAHADUR@leidos.com		Works with Bill Samuels	WMG
2	YES	Bob Clark		US EPA retired	Ex. 6 Personal Privacy (PP)			WMG
3	YES	Dan Cole	Sr. Director of Technical Services	IAPMO	Dan.Cole@iapmo.org		IAPMO develops and adopts national building plumbing codes	SGB
4	YES	Toju Omaghomi	ORISE Fellow	US EPA	Omaghomi.Tortsetu@epa.gov		Recent dissertation deals with peak demands and heat loss in premise plumbing systems	SGB
5	YES	Julius Ballanco	Plumbing Engineer	JBEngineering	Ex. 6 Personal Privacy (PP)		Former President of ASPE; very knowledgeable on premise plumb issues	SGB
6	YES	Kerry Hamilton	Asst Professor	Arizona State University	Kerry.Hamilton@asu.edu		Publications relevant to premise plumbing	RJ
7	YES	Patrick Gurian	Professor	Drexel University	plg28@drexel.edu		Publications relevant to premise plumbing	RJ
8	YES	Grace Jang	Project Contact	WRF	hjang@waterrf.org		the Levels of Legionella in Service Lines and Premise Pluminbing". Grace or someone else from WRF may be interested in attending.	WEP
9	YES	Darren Lytle		US EPA	lytle.darren@epa.gov		Signficant researc on water quality in premise plumbing systems	
10	YES	Jim Lutz			jdlutz@hotwaterresearch.net			
11	YES	Gary Klein			gary@garykleinassociates.com;			
	No response (no longer with WRF)							
12		Beate Wright			bwright@waterrf.org			
13	No response	Sasha Schück		Univ. of Arizona ?	Ex. 6 Personal Privacy (PP)		Kevin Lansey's student. His MS thesis in 2018 was "Water Age in Residential Premise Plumbing" in which he used EPANET and SIMDEUM	WMG
14	No response	Kevin Morley	Manager Federal Relations	AWWA	KMorley@awwa.org		Interest in premise plumbing issues and concerns	
15	No response	Jun Yan		Bentley	Jun.Yan@bentley.com		Mixing in on-premise storage tanks	WMG
16	No response	Mike Schock		US EPA	schock.michael@epa.gov		Corrosion control of premise plumbing and distribution systems	WMG
17	NO	Joost van Summeren		KWR Watercycle Research Inst	joost.van.Summeren@kwrwater.nl		Doing research on design of premise pumbing in tall buildings. Works with Mirjam.	WMG
18	NO	Peter DeMarco	Sr. VP of Advocacy and Research	IAPMO	Pete.Demarco@iapmo.org	not available		SGB
19	NO	Charles Nathan Haas	Professor	Drexel University	??		Publications/experience	
20	NO	Ed McBean			emcbean@uoguelph.ca			
21	NO	Peter Mayer			peter.mayer@waterdm.com;			
22	NO	Bill Healy			william.healy@nist.gov			
							Instructions: Add names and copy all on the TC.	

LEGEND

IAPMO	International Association of Plumbing and Mechanical Officials
ASPE	American Society of Plumbing Engineers
WRF	Water Research Foundation
KWR	Kiwa Water Research

Last Update: 12/18/19

ATTACHMENT II

Recommended participant list from the second wave

MANHATTAN COLLEGE

JUNESEOK LEE <jlee04@manhattan.edu>

USEPA | Premise Plumbing Workshop

Gary Klein Associates <gary@garykleinassociates.com> Wed, Dec 18, 2019 at 1:43 PM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>, "Buchberger, Steven (buchbesg)" <buchbesg@ucmail.uc.edu>

Juneseok and Steve: Here are a few names of people and organization to consider inviting to participate in the workshop. Each of the four represent different parts of the plumbing industry.

Matt Sigler, Plumbing Manufacturers Institute, Matt Sigler, msigler@safeplumbing.org

Andrew Kireta, Jr., Copper Development Association, andy.kiretajr@copperalliance.us

Mike Cudahy, Plastic Pipe and Fittings Association, mikec@cmservices.com

Lance MacNevin, Plastic Pipe Institute, lmacnevin@plasticpipe.org

I do not have a specific contacts at the two following organizations:

Association of Home Appliance Manufacturers (AHAM). Randy Cooper, Vice President, Technical Operations & Standards rcooper@aham.org looks to be a likely starting place. They represent dishwashers and washing machine manufacturers.

Air-conditioning, Heating and Refrigeration Institute (AHRI). Tae Kwon, Manager, Sector Services, Heating tkwon@ahrinet.org looks to be a good starting place. They represent water heating equipment manufacturers.

Jim Lutz probably has some good ideas about energy modelers.

All the best. Gary

> On Dec 10, 2019, at 11:11 AM, Lee, Juneseok <Juneseok.Lee@manhattan.edu> wrote:
>
> [Quoted text hidden]

MANHATTAN COLLEGE

JUNESEOK LEE <jlee04@manhattan.edu>

USEPA | Premise Plumbing Workshop

jbengineer@aol.com <Ex. 6 Personal Privacy (PP)> Tue, Dec 17, 2019 at 7:12 PM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>
Cc: "Murray, Regan" <Murray.Regan@epa.gov>, "Buchberger, Steven (buchbesg)" <buchbesg@ucmail.uc.edu>, "Burkhardt, Jonathan" <Burkhardt.Jonathan@epa.gov>, Walter Grayman Ex. 6 Personal Privacy (PP)

Prof. Lee,

My apologies for the delay in responding. I had to make sure that I could keep my calendar clear for the dates. I remembered over the weekend that I needed to contact you when I drove right past the EPA facility in Cincinnati while attending my daughter Masters degree ceremony at Miami University.

I greatly appreciate the invitation to participate. Premise Plumbing Modeling is a subject near and dear to my heart. Hence, I would love to participate in the workshop.

Prof Buchberger and I have been discussing a subject matter on modeling of water piping systems that is often ignored, stadiums and large arenas. I have spoken in the past on the design issues related to these facilities. I would be happy to make a presentation on this subject matter if you would like. I am open to speaking on any other subject you might request.

As for other individuals, I would suggest you also contact the following individuals if you have not already done so:

David Dexter, P.E., CPD. FASPE, FNSPE

Principal Engineer

Mechanical, Plumbing & Fire Protection

3D Engineering Consultants, LLC

6065 Detrick Rd.

Tipp City, Ohio 45371-2109

Phone: (937) 667-8846

Cell: (937) 609-5969

E-mail: plbgegr@gmail.com

Dr. Saum Nour, P.E.

Absolute Consulting Engineers

3839 Birch

Newport Beach California 92660

877-852 7755

949-852 8700

949-852 8001

Fax: 949 - 852 1918

E-mail: snour@absoluteco.com

Billy Smith, FASPE

Executive Director

ASPE (I'm sure he is already on your list)

J. Joe Scott, CPD

Plumbing

Cannon

One City Centre

St. Louis, MO 63101

(314) 241-6250

JScott@CANNONdesign.com

J. Richard Wagner, PE.

Principal Engineer

Environmental Engineering Co.

4530 Hollins Ferry Road

Baltimore, MD 21227-4670

(410) 247-2200

Peter A. Kraut, P.E.

President

South Coast Engineering Group, Inc.

23901 Calabasas Road, Suite # 1068

Calabasas, CA 91302

(818) 224-2700

pkraut@socoeng.com

Again, thank you for contacting me. Let me know if there is anything else, I can do to assist you.

Julius

Julius Ballanco, P.E.

President

JB Engineering and Code Consulting, P.C.

1661 Cardinal Drive

Munster, IN 46321

(219) 922-6171

(219) 922-6172 facsimile

JBEngineer@aol.com

www.jbengineer.com

[Quoted text hidden]

MANHATTAN COLLEGE

JUNESEOK LEE <jlee04@manhattan.edu>

USEPA | Premise Plumbing Workshop

rmclark@fuse.net <Ex. 6 Personal Privacy (PP)> Mon, Dec 16, 2019 at 10:45 AM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>
Cc: Steve Buchberger <steven.buchberger@uc.edu>, Walter Grayman Ex. 6 Personal Privacy (PP), Regan Murray <Murray.Regan@epa.gov>, Jonathan Burkhardt <Burkhardt.Jonathan@epa.gov>

Juneseok,

I apologize for not getting back to you sooner but I got diverted onto some other things. However, I have been giving a lot of thought to your proposal.

First I'd like to thank you for the invitation to participate in your Premise Plumbing Modeling (PPM) Workshop. It sounds like a very timely and worthwhile effort. As you know, when the Safe Drinking Water Act (SDWA) was passed in 1974 there was a great deal of discussion as to where the regulations promulgated under the act would be applied. The drinking water utility industry and some of the more conservative state and EPA staff assumed the regulations would apply at the discharge point from the water treatment plant. This issue remained undecided for several years after the Act was passed. During the late seventies and early eighties, we initiated research (as did several other groups) focused on understanding the changes in water quality that take place in the drinking water distribution system after treatment. We discovered that the potential for water quality deterioration in the network was dramatic and that the system itself and system operating policies could result in water quality deterioration. One of the products from our research was EPANET. I believe it was this research that caused EPA's Office of Drinking Water to make a ruling that the SDWA regulations would apply at the household service connection. Not a popular decision with the water utilities.

We became aware of the potential for lead exposure from house hold plumbing and started research to support EPA's Lead and Copper (L&C) Rule which was promulgated in 1991. I've attached a report that I prepared for the House Appropriations Committee in 1987 summarizing our corrosion research. Leading up to the promulgation of the L&C rule there was enormous controversy about the requirement that samples be taken in the premise plumbing. It is now clear that the unique characteristics of premise plumbing can have a major impact on water quality. In addition to corrosion and lead leaching issues the high ratio of surface area to volume, long stagnation times, and low disinfection residuals create conditions favorable for opportunistic pathogens such as *Legionella pneumophila*, *Mycobacterium avium complex* and other nontuberculous mycobacterium and *Pseudomonas aeruginosa*.

A suggestion, because of the potential controversy around the issue of premise plumbing, is to make sure you have broad representation in your seminar. I'd like to suggest Jeff Swertfeger ot the Greater Cincinnati Water Works as a possible candidate, Jeff's e-mail is Jeff.Swertfeger@gcww.cincinnati-oh.gov. Since the issue of possible regulations dealing with premise plumbing has the potential for being very controversial you might consider contacting the Association of State Drinking Water Administrators. Alan Roberson is their Executive Director. You might also contact someone at the National Institute of Technology (formerly the National Bureau of Standards) to find out what they are doing in this area. Steve may have some thoughts about this idea.

My experience with the effect of premise plumbing on water quality is limited. I did serve on the EPA Water Protection Task Force from 2001-2002 where the issue of premise plumbing was raised. After retiring in 2002, I worked with Steve and Walter on a project in collaboration with Sandia National Labs in which the effect of premise plumbing was minimally addressed. In 2005-2006 I served om a National Research Council task force addressing "Drinking Water Distribution systems: Assessing and Reducing Risks" which highlighted premise plumbing as a major contributor to the degradation of water quality. After retiring I also worked with the State Department. We addressed the vulnerability of US Embassies to water quality problems and I did an evaluation of the embassy in Moscow and found some major security issues.

I'm not sure how I can help you but I certainly wish you luck. Please let me know if you have any questions or if I can be of assistance.

Bob

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Clark, Internal Corrosion In Drinking Water Distribution Systems- A Report to Congress on EPA's Research Activities.pdf
10344K

USEPA | Premise Plumbing Workshop

Gurian,Patrick <plg28@drexel.edu> Mon, Dec 16, 2019 at 9:40 AM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>
Cc: "Murray, Regan" <Murray.Regan@epa.gov>, "Buchberger, Steven (buchbesg)" <buchbesg@ucmail.uc.edu>, "Burkhardt, Jonathan" <Burkhardt.Jonathan@epa.gov>, Walter Grayman <Ex. 6 Personal Privacy (PP)>

I am interested in attending. My areas of interest are

1. Consistency and specificity of guidance to building facility managers, particularly on
    a. Managing water age, nitrification, and residual decay
    b. Managing temperature
2. Risk informed standard setting for opportunistic pathogens

There are a lot of potential participants that I can think of. If you have particular gaps (microbiologist, risk assessment, water utility, building design, etc.) then I can probably suggest people.

Thanks, Patrick

From: Lee, Juneseok <Juneseok.Lee@manhattan.edu>
Sent: Tuesday, December 10, 2019 2:12 PM
To: Gurian,Patrick <plg28@drexel.edu>
Cc: Murray, Regan <Murray.Regan@epa.gov>; Buchberger, Steven (buchbesg) <buchbesg@ucmail.uc.edu>; Burkhardt, Jonathan <Burkhardt.Jonathan@epa.gov>; Walter Grayman <wgrayman@gmail.com>
Subject: USEPA | Premise Plumbing Workshop

EXTERNAL.

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MANHATTAN COLLEGE

JUNESEOK LEE <jlee04@manhattan.edu>

USEPA | Premise Plumbing Workshop

Dan Cole <dan.cole@iapmo.org> Wed, Dec 11, 2019 at 2:48 PM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>
Cc: "Murray, Regan" <Murray.Regan@epa.gov>, "Buchberger, Steven (buchbesg)" <buchbesg@ucmail.uc.edu>, "Burkhardt, Jonathan" <Burkhardt.Jonathan@epa.gov>, Walter Grayman [Ex. 6 Personal Privacy (PP)]

Dear Mr. Juneseok,

I accept your invitation to participate in the workshop. The particular areas of interest and contribution to the workshop would be that which is related to pipe sizing. Having worked with a team (inclusive of Dr. Buchberger) to revise Hunter's Curve to estimate peak water demand in buildings, we devised a new method of estimating peak water demand for single and multi-family dwellings. We can bring this methodology to the workshop. Other elements requiring analysis in a premise water distribution system would be measuring pressure drop, velocity parameters relating to different types of piping material, water temperature and stagnation relating to pathogens, hot water delivery time-to-tap relating to water waste, and identifying the water-energy nexus in premise plumbing.

For sewage systems, there is a need to develop a new computational method that estimates the peak sewage demand in buildings. The problem is significantly different than peak water demand since it concerns the discharges of waste into a drainage system where the probability of overlapping discharges will determine the peak demand. Also the flow characteristics differ between the initial surge discharge and the flattened terminal velocity flow due to gravity, as well as the differences between horizontal drain flows and vertical stack flows. The National Bureau of Standards did a significant amount of research in drain and stack flow modelling that needs to be revisited.

Recommended participants: Julius Ballanco from the American Society of Plumbing Engineers. Mike Cudahy from the Plastic Pipes Institute. Matt Sigler from the Plumbing Manufacturers International.

Regards,

Dan Cole

Sr. Director of Technical Services

WEStand Secretariat

p: 708-995-3009 | f: 708-479-6023 | e: dan.cole@iapmo.org

IAPMO

Chicago Regional Office

18927 Hickory Creek Drive, Suite 220

Mokena, IL 60448

Please consider the environment before printing this email.

From: Lee, Juneseok <Juneseok.Lee@manhattan.edu>
Sent: Tuesday, December 10, 2019 1:10 PM
To: Dan Cole <dan.cole@iapmo.org>
Cc: Murray, Regan <Murray.Regan@epa.gov>; Buchberger, Steven (buchbesg) <buchbesg@ucmail.uc.edu>; Burkhardt, Jonathan <Burkhardt.Jonathan@epa.gov>; Walter Grayman <wgrayman@gmail.com>
Subject: USEPA | Premise Plumbing Workshop

December 10, 2019

Dear Mr. Cole:

USEPA will host a Premise Plumbing Modeling (PPM) Workshop on April 22-23, 2020 at the US EPA Breidenbach Lab, in Cincinnati, Ohio USA. The PPM Workshop is being organized by the Premise Plumbing Modeling Task Committee under the Water Distribution Systems Analysis Committee of ASCE EWRI.

The PPM Task Committee was formed in September 2019 under the auspices of ASCE EWRI. Its main objective is to advance our understanding of the science of this new field. The Task Committee's deliverables will be applied to help develop new building water systems management tools for use by practicing engineers, as well as the water distribution research community.

The objective of the PPM Workshop will be to collect and disseminate knowledge regarding the current state of building water system modeling and the linkages to design, analysis, and practical operational decision-making. In particular, we intend to identify gaps in our existing knowledge, data, and capabilities. Note that we are specifically focusing on the 'Modeling efforts of Potable Water Systems' in this workshop. However, we're open to including additional topics that address the extension of premise plumbing modeling to sewage plumbing systems (or vice versa).

We are writing to ask whether you would be interested in participating in this workshop. We would greatly appreciate it if you can let us know by December 18, 2019, along with an indication of your particular areas of interest and expected contributions to the workshop. This will greatly help us organize appropriate discussion points and focus groups.

Also, we are compiling other potential workshop participants. We would greatly appreciate it if you can recommend one or more participant(s). On a side note, we do not anticipate the need to charge a registration fee for the workshop, although all the participants will be responsible for their own travel costs, lodging, and meals.

If you have any questions or would like to discuss the Task Committee's objectives or suggest potentially useful future directions, we would very much appreciate you getting in touch with any of the members of the organizing committee, who are listed below along with their contact information.

Thank you for your attention and we look forward to hearing from you.

Sincerely,

Juneseok Lee, Manhattan College, Juneseok.Lee@manhattan.edu

Jonathan Burkhardt, USEPA, Burkhardt.Jonathan@epa.gov

Steven Buchberger, University of Cincinnati, Steven.Buchberger@uc.edu

Regan Murray, USEPA, Murray.Regan@epa.gov

Walter Grayman, Consulting Engineer, Ex. 6 Personal Privacy (PP)

JUNESEOK LEE, PhD, PE, D.WRE

Associate Professor

Civil & Environmental Engineering

Riverdale, NY 10471 | P: (718)862-7318

Manhattan College | Lee Water-Infra Analytics

USEPA | Premise Plumbing Workshop

Jim Lutz <jdlutz@hotwaterresearch.net> Wed, Dec 11, 2019 at 12:21 PM
To: "Lee, Juneseok" <Juneseok.Lee@manhattan.edu>
Cc: "Murray, Regan" <Murray.Regan@epa.gov>, "Buchberger, Steven (buchbesg)" <buchbesg@ucmail.uc.edu>, "Burkhardt, Jonathan" <Burkhardt.Jonathan@epa.gov>, Walter Grayman [Ex. 6 Personal Privacy (PP)]

Juneseok,

Yes, I would be interested in participating in the workshop. Please send me more information about it.

Also, on the topic of modeling potable water systems, it looks like there will be at least a couple sessions on that topic at this year's Hot Water Forum. It's in Atlanta March 23 and 24.

Perhaps you or one of your colleagues would be able to attend. I could also put you in contact with some of the proposed speakers.

thanks,

Jim

Jim Lutz
+1(510)459-9635
jdlutz@hotwaterresearch.net

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ATTACHMENT III

Example papers

USE OF EPANET PREMISE PLUMBING MODELS IN CONTAMINATION STUDIES

Walter M. Grayman[1], Steven Buchberger[2] and William Samuels[3]

[1] W.M. Grayman Consulting Engineer, Oakland, California USA; email: wgrayman@gmail.com
[2] Civil and Architectural Engineering and Construction Management, University of Cincinnati Cincinnati, Ohio USA; email: Steven.Buchberger@uc.edu
[3] Leidos, Alexandria, Virginia USA; email: samuelsw@leidos.com

ABSTRACT

The use of standard extended period system EPANET models of premise plumbing in residential and high rise buildings to assess their vulnerability to contamination of the drinking water supply is described. This analysis is applicable to either accidental contamination events such as cross connections within the building or intentional contamination events. The residential model includes all piping in both the cold water system and the hot water system. The high rise model includes the pumping system, tanks, check valves, major vertical backbone piping and a skeletonized representation of the delivery pipes on each floor.

INTRODUCTION

Hydraulic models have been applied quite widely to study the movement of contaminants in drinking water distribution systems. Typically such models include only the distribution system up to the point where the service connection meets the water main in the street, or as is the case in most models, at a node on the main representing the water use of several individual service connections in the vicinity of that node. When used to calculate human exposure resulting from an intentional or accidental contamination event, the distribution system models neglect the dynamics and impacts of premise plumbing on the exposure calculations. This paper demonstrates the use of standard extended period system EPANET models of premise plumbing in residential and high rise buildings to assess their vulnerability to contamination of the drinking water supply either within the distribution system or directly to the premise plumbing. It is based on the publications of Grayman and Buchberger (2006), Grayman et al. (2008), and Samuels et al (2010).

In the past few years, there has been a renewed interest in modeling premise plumbing. Schück (2018) and Burkhardt et al (2019) modeled water age in premise plumbing; Omaghomi (2019) studied peak demands and energy loss in premise plumbing. Lee and Whelton discuss the use of EPANET and EPANET-MSX in modeling hydraulics and water quality in premise plumbing.

MODELING RESIDENTIAL BUILDINGS

Figure 1 shows a link-node schematic of indoor plumbing in an example single-family, 4-bedroom residence used in the analysis. There is a curbside service connection to the six inch municipal mainline. The cold water supply is shown in blue and the hot water supply in red. As is typical of most indoor plumbing, the supply lines are designed in a branching dendritic pattern (*i.e.*, no looping).

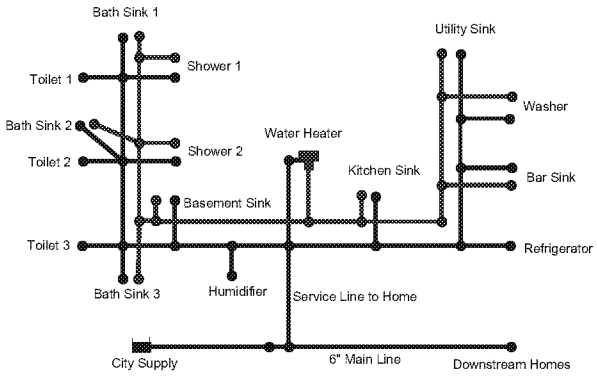

Figure 1. Indoor plumbing in single-family 4-bedroom residence

Water usage in a residence is very different than the typical water usage patterns assigned to nodes in most water distribution system models. In a residence, water usage occurs as relatively short duration pulses (typically on the order of minutes or shorter) with concentrated usage during certain periods of the day and little or no water use generally during the night time.

In order to demonstrate the movement of contaminants into and through the building, an external contamination event was modeled. A hypothetical conservative contaminant was simulated as a mass slug with concentration of 1 mg/L for 12 hours (9 AM to 9 PM) in the 6-inch city mainline feeding the residence. EPANET was used to simulate movement of the contaminant from the mainline into the home and through the house. The resulting concentrations are shown in the house at two points in time: at 10 AM which is one-hour after the start of the event and at the end of the event (in the city main) at 9 PM, which is 12 hours after the start of the event.

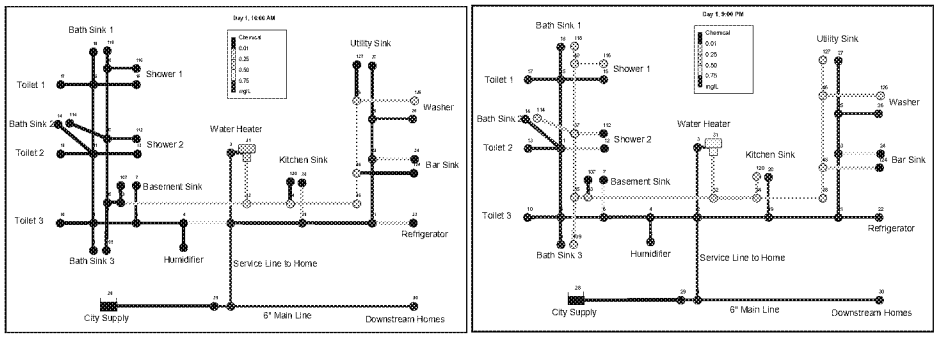

Figure 2. Contaminant concentration in the residence at 10 AM and 9 PM

At 10 AM, the contaminant has reached only one fixture, the washing machine through both the hot water and cold water system. By 9 PM, the contaminant has spread throughout the house. Due to the branching network and advective flow regime, the concentrations in the cold water system are relatively constant and reflective of the concentration of the contaminated pulse

entering the residential system from the distribution system. However, the concentration in the hot water system is affected by the dilution within the hot water heater resulting in a gradually decreasing concentration over time as the contaminant is diluted by uncontaminated water entering the hot water heater.

The development of a model of the plumbing system of a residence involves two primary tasks: (1) definition of the physical layout of the system; and (2) description of the water use patterns. The former task is generally quite straightforward and can be accomplished by physically tracing the piping system or referring to house plans. Definition of water use patterns (Buchberger *et al.*, 2003; Mayer *et al.*, in press) can be considerably more difficult and since movement of water through the system is controlled primarily by short-term, instantaneous random demands, the importance of this information is paramount in modeling water quality in residential settings.

MODELING HIGH RISE BUILDINGS

In larger cities in downtown areas, development is dominated by high rise buildings. The potential impacts of an intentional or accidental contamination event entering or within a high rise building was studied using an EPANET model. Scenarios investigated included different locations for the injection, and different injection quantities, durations and times. The hydraulic models represented a generic 48-story building divided into two vertical zones. Models with two different levels of detail were constructed, a simplified model represented by a single demand node on each floor (Figure 3a) and a more complex and realistic model representing a connection every third floor with a pressure reducing valve serving three floors with a demand node on each floor (Figure 3b).

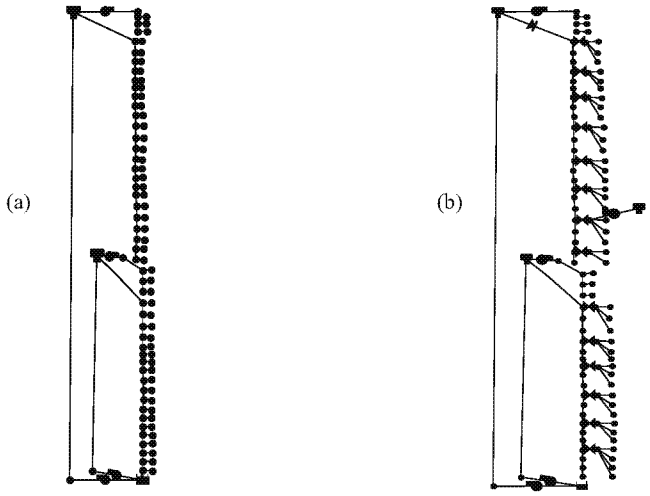

Figure 3. Vertical profiles of (a) simplified and (b) more detailed model of 48-story high rise building

The connection to the water distribution system is represented by the reservoir that delivers water at a designated pressure head. Two pumps located in the basement deliver water to 16,000 gallon tanks located at the top and mid level of the building. The two pumps are

controlled by the water level in each tank with the pump set to go on when the water level drops to 4 feet and to go off when the water level rises to 9.5 feet above the bottom of the tank. The pumps are designed to deliver 65 gpm to the tanks. In order to provide sufficient pressure to the three floors immediately below each tank, an in-line booster pump is located adjacent to each tank.

Demand (water usage) was estimated by somewhat arbitrarily assuming 50 workers per floor, each using 20 gpcd. This corresponds to 1000 gal/day/floor, which results in approximately 0.7 gpm/floor. This value was rounded up to 1 gpm/floor to include other maintenance usage. The demand is assumed to be a composite of all of the usage on the floor (toilets, sinks, *etc.*).

Commented [SWB[1]]: Any new studies on high rise buildings that might validate these assumptions?

The impact of an external contamination event on the building was demonstrated by assuming that the inflow line from the city was contaminated with a conservative substance at a concentration of 400 mg/L for a 3-hour period starting at noon. During the nighttime when water usage in the building is very low, little water is used from the tanks and the pumps do not need to operate to refill the tanks. As a result, for this example, a contaminant in the city's water line during the period from midnight until 7 AM would not be drawn into the building. For the case of the 3-hour contamination event (from noon until 3 PM), only the pump serving the roof tank is operating so that no contamination enters the mid level tank and as a result, the lower 22 floors in the building would not be contaminated.

As water is consumed in the upper half of the building, the contaminated water is drawn from the roof tank and delivered to the fixtures on the affected floors. The progression of floors impacted by the contamination and the resulting concentrations are shown in Figure 4. This Figure shows snapshots of the building at 1 PM, 2 PM and 5 PM representing 1 hour, 2 hours and 5 hours after the start of the contamination event. As expected, no contaminated water is delivered to the lower floors served by the mid-level tank.

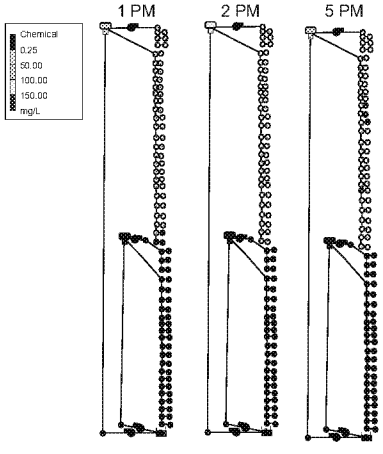

Figure 4. Snapshots of high-rise building water system showing contaminant concentration

Similar to the residential case, the development of a model of the plumbing system of a high rise building involves two primary tasks: (1) definition of the physical layout of the system; and (2) description of the water use patterns. The former task requires examination of building plans and generally requires discussions with the operating and/or design engineers. Decisions must be

made on the level of detail to represent in the model including the floor-by-floor tie-in to the backbone system and the level of detail represented on each floor. Definition of water use patterns are not as time-sensitive as is the case in residential buildings because of the presence of tanks that "buffer" the impacts of individual short-term water use pulses. However, knowledge of the general diurnal water use patterns and locations of specific higher water use areas such as restaurants in the buildings are necessary to model the movement of contaminants through the internal water system.

SUMMARY AND CONCLUSIONS

Hydraulic models of the internal premise piping system can be developed and used to trace the movement of contaminants through the building water system. They can be used in assessing the vulnerability of the buildings to both accidental and intentional contaminant events resulting from sources within the distribution system feeding the building or internally within the building. Models of residential and high-rise buildings were built and several hypothetical contamination events were investigated. Contamination movement in residential buildings were found to be very sensitive to the detailed fixture level water usage patterns within the residence. In high-rise buildings, entry of contamination from the city distribution system and movement of the contaminants through the building were found to be most sensitive to the operational aspects of the internal water system. This included the interaction of pump operation and the roof and other internal tanks within the building.

In this work, a standard EPANET model was used. Improvements in modeling may be possible when factors such as dispersion, water quality transformations and operation of water heaters are included. Methods of integrating EPANET with CAD packages and 3-D displays in a BIM platform could streamline the model construction and display.

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SHOULD AN EPANET SOFTWARE PACKAGE ESPECIALLY FOR MODELING PREMISE PLUMBING BE BUILT?

Walter M. Grayman[1], Jonathan Burkhardt[2] and Regan Murray[3]

[1] W.M. Grayman Consulting Engineer, Oakland, California USA, email: wgrayman@gmail.com
[2] USEPA, Water Infrastructure Division. Cincinnati, Ohio, email: Burkhardt.Jonathan@epa.gov
[3] USEPA, Water Infrastructure Division. Cincinnati, Ohio, email: Murray.Regan@epa.gov

ABSTRACT

Standard EPANET and other water distribution system modeling software packages have been used on an experimental basis to model premise plumbing in residences and commercial buildings. However, some simplifications and compromises are needed when applying the standard software to account for differences from water distribution applications. Areas where modifications in the software may be needed in terms of both the calculation engine and the software interface modification in the software are explored. The paper is designed to stimulate the discussion on this subject at the Premise Plumbing Modeling Workshop in Cincinnati, Ohio on April 22-23, 2020.

INTRODUCTION

EPANET and other software packages are widely used to model the hydraulics and water quality in water distribution systems. Several researchers have applied these standard packages for modeling premise plumbing in residences and commercial buildings; for example, Grayman et al. (2008), Schück (2018), Burkhardt et al (2019), and Lee and Whelton (2018). However, efficient and effective use of a standard modeling software package, when applied to premise plumbing, results in some needed simplifications and compromises. The purpose of this paper is to explore the nature of these simplifications, what changes may be needed when modeling premise plumbing, and ultimately, to start the discussion on whether a special-purpose software package for modeling premise plumbing should be built and what it should look like. As such, the paper is not meant to be a detailed, definitive, comprehensive tome on modeling premise plumbing, but rather, it is designed to stimulate the discussion on this subject at the Premise Plumbing Modeling Workshop to be held in Cincinnati, Ohio on April 22-23, 2020.

This paper addresses two primary areas: (1) modifications in the way that EPANET simulates the hydraulic and water quality behavior (i.e., the engine); and (2) modifications in the interface and integration aspects of the software.

SIMULATION ISSUES

There are several potential areas where modifications/augmentations may be needed in the EPANET simulation engine in order to better support modeling of premise plumbing. Some of these areas are discussed below.

1. Dispersion and laminar flow: The basic EPANET engine assumes that flow is in the turbulent regime and ignores the explicit representation of dispersion in pipe flow. These topics have been addressed by many researchers and, in fact, experimental versions of

EPANET have been developed that explicitly include dispersion. Woo et al. (2018) discuss this topic as it applies to modeling premise plumbing.

2. Water demand: In standard EPANET, demands are defined by a fixed flow rate over a defined, typically long, period of time and controlled by patterns. In contrast, demands in PPS are random and of short duration. Applying EPANET to PPS can be possible, however stagnant periods must be explicitly defined for each fixture at a short water quality timestep, leading to large difficult-to-decipher patterns. Experimental versions of EPANET have extended this to include pressure dependent demands (PDD) where the flow usage rate varies with the pressure. In plumbing fixtures, a further extension may be needed to represent situations such as toilets, washing machines and other fixtures where the volume of water used during an event follows a pattern that may be complex; for example, during a washing machine cycle there is a period of filling, a stagnant non-water use period, followed by a rinse fill cycle, and another stagnant period that all correspond to a single in-use cycle. Uses in PPS are inherently random, requiring some level of stochastic modeling for demands. For example, a toilet is not flushed at the same time each day, but rather quasi-randomly dependent on the time of day and occupancy. Blokker et al (2017) and Buchberger (2003) have studied this phenomena and incorporation of these concepts in a premise plumbing version of EPANET should be considered.

3. Multi-Species Modeling:

    a. Temperature modeling: Premise plumbing includes both a cold water and hot water system. This may necessitate several modifications when modeling premise plumbing including: operation and mixing characteristics of hot water heaters; temperature dynamics in the piping system; and incorporation of the effects of temperature on water quality reactions. Several researchers have studied this temperature in distribution systems, e.g., Blokker and Pieterse-Quirijns (2013). Heat loss calculations require more information than is currently stored in EPANET models.
    b. Modeling Legionella or other bacteria requires temperatures, disinfectant type and concentration, and bacterial concentrations to be modeled.
    c. Modeling of other PPS contaminants, such as metals, could be improved by modeling multi-species. Using pH, temperature, disinfectant concentration and others could provide more comprehensive models compared to the first order model available in the current EPANET.

INTERFACE AND INTEGRATION ISSUES

There are several topics related to the interface and integration in the design of a premise plumbing version of EPANET. Some of these areas are discussed below.

1. Graphical user interface (GUI): Many elements of a GUI for a premise plumbing modeling version of EPANET differ from the standard EPANET version. One example is the

symbology and characteristics of the individual components in a premise plumbing network. Figure 1 is a mockup of a palette of symbology of premise plumbing components.

a. In addition to symbology, these icons could access complex pattern information about types of uses that are associated with each fixture.

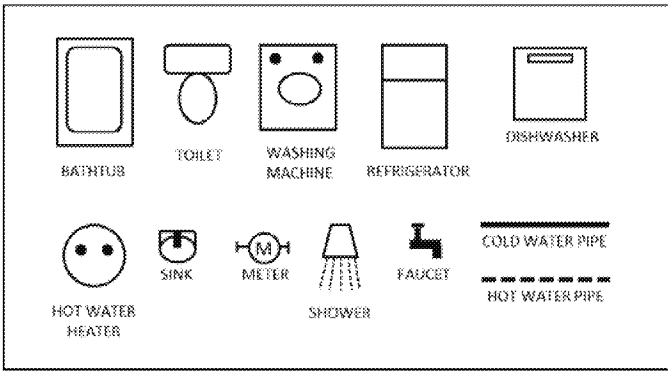

Figure 1. Mockup of a palette of premise plumbing components

2. 3-D display of premise plumbing systems: Whereas typical water distribution systems generally can be displayed in two dimensions, premise plumbing systems are inherently three dimensional and, as a result, a screen or printed display of a premise plumbing system in a building needs to show results and interactions between components on different floors. This is inherently more complex than a standard planar. 2-D view of a distribution system.

3. Integration with CAD packages: CAD systems have long been used to depict plumbing systems within a building. A mechanism for using an existing CAD drawing of a building plumbing system in the construction of a network model would greatly facilitate building such models.

SUMMARY AND CONCLUSIONS

EPANET and other water distribution system modeling software have been applied to simulate hydraulics and water quality in the premise plumbing systems in residences and large venues. However, since there are some differences between water distribution systems and premise plumbing systems, use of standard software results in some needed simplifications and compromises. The nature of these differences and potential areas where modifications in the software may be needed were explored in terms of both the calculation engine and the software interface. The paper is not meant as a comprehensive review, but rather, is designed to stimulate the discussion on this subject at the Premise Plumbing Modeling Workshop in Cincinnati, Ohio on April 22-23, 2020.

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ATTACHMENT IV

Draft Research Gap Document Template

ASCE EWRI Premise Plumbing Modeling Workshop
US EPA Breidenbach Lab, Cincinnati, Ohio 45220
April 22-23, 2020

Research Gaps in Premise Plumbing Modeling (DRAFT TEMPLATE)

Name(s):

Topic Area and Focus:

	Topic Area	Focus
1	Water Quantity	
2	Water Quality	
3	Regulations and Codes	
4	(list)	

	Problem Statement (100 words max)
1	
2	
3	
4	
5	
6	

	Research Needed (100 words max)
1	
2	
3	
4	
5	
6	

	Data Needed (60 words max)
1	
2	
3	
4	

	Applications (60 words max)
1	
2	
3	
4	

	References (optional)
1	
2	
3	
4	

(Please do not exceed one page using Calibri 11 font style and size)

ATTACHMENT V

Preliminary schedule leading to workshop

November 24, 2019

Steve,

As promised, following is some information that is relevant to the workshop. Feel free to either incorporate any of this in the minutes or else include this memo when you circulate the minutes.

Best wishes, Walter

COLLABORATE

We can use the EWRI Collaborate site for the Premise Plumbing Modeling Task Committee for storing and exchanging files. Members of the task committee can sign in and access it.

Current members of task committee are:

Lee, Juneseok	Juneseok.Lee@manhattan.edu
Burkhardt, Jonathan	Burkhardt.Jonathan@epa.gov
Buchberger, Steven	buchbesg@ucmail.uc.edu
Murray, Regan	Murray.Regan@epa.gov
Grayman, Walter	Ex. 6 Personal Privacy (PP)

I will arrange for the other people on the workshop organizing committee to also have access to the site:

platten.william	platten.william@epa.gov
Haxton.Terranna	Haxton.Terra@epa.gov
Janke, Robert	Janke.Robert@epa.gov

We can add other participants in the workshop to the task committee if we want so that they can access the material on the site.

I have established three folders on the site: Literature, PPM Workshop and Admin. My idea is that we can store relevant papers in the Literature folder so that other members of the task committee can see them. Currently I have put one paper there but will add other ones shortly. Other members can also store papers there though it is possible that only the community admin members (Buchberger, Grayman and Lee) can actually store papers in the folder – if that is the case then other members can email their papers to one of us and we can upload them.

A FIRST CUT SCHEDULE FOR PREPARING FOR THE WORKSHOP

Following is a first cut schedule for preparing for the workshop. Comments, suggestions, changes are encouraged:

December 3, 2019: Walter will publicize the workshop at the AWWA EMAC conference call and ask if there is anyone on the call who has worked in this field and may be interested in participating. They will be asked to email me immediately if they are interested and want to be considered.

December 9: Next committee conference call (tentative). Choose next set of potential participants.

December 10: Send emails to next set of potential participants to inquire about their interest and their area of work in premise plumbing modeling

December 19 (or 20): Next committee conference call (tentative). Develop a list of invitees.

January 2, 2020: Issue invitations. Include a schedule and a sample paper. Ask participants to RSVP by January 15.

February 1, 2020: Participants should submit a title and short (<100 word) abstract.

February 10: If there are holes in the program, identify other potential participants.

February 15: Prepare a preliminary technical program for the workshop base on abstracts.

March 15: All papers are due (3 to 5 pages). Papers will be posted on web site when we receive them.

March 20: Issue near final program for the workshop.

March 23 or 24: Final date for participants to make hotel reservations.

April 1: Finalize logistical details.

April 22-23: Workshop.

SAMPLE PAPER

I have volunteered to prepare a sample 3 to 5-page paper for distribution as an example. I will try to have this sample done by December 15 so that all can comment on it before we distribute it. I have asked EWRI to provide the format guide for papers to be used as part of a committee report.

KEVIN LANSEY

Kevin had indicated that he would not be able to able. I emailed him to encourage him to maybe change his mind. Also asked him for contact information on his ex-student Sasha Schück whose 2018 Master's thesis was titled, "Water Age in Residential Premise Plumbing".